

WHAT IS CLAIMED IS:

- 1 1. A method for reducing stiction in a MEMS device having a moveable element
2 moveably coupled to a substrate, the method comprising:
 - 3 a) providing the substrate with an anti-stiction member; and
 - 4 b) interposing the anti-stiction member between the moveable element and the
5 substrate.
- 1 2. The method of claim 1 wherein step b) includes actuating the moveable
2 element to interpose the anti-stiction member between the moveable element
3 and the substrate.
- 1 3. The method of claim 2 wherein step b) includes substantially immersing the
2 moveable element in a liquid during actuation of the moveable element.
- 1 4. The method of claim 1, wherein step a) includes providing an anti-stiction
2 member that overhangs the moveable element.
- 1 5. The method of claim 4, wherein the anti-stiction member includes one or more
2 flexible portions.
- 1 6. The method of claim 5, wherein the one or more flexible portions includes at
2 least one double-serpentine portion.
- 1 7. The method of claim 4 wherein the anti-stiction member is made of a flexible
2 material.
- 1 8. The method of claim 4 wherein step b) includes actuating the moveable
2 element whereby the moveable element engages the anti-stiction member
3 causing the anti-stiction member to flex.
- 1 9. The method of claim 8 wherein step b) includes flexing the anti-stiction
2 member sufficiently to interpose the anti-stiction member between the
3 moveable element and the substrate
- 1 10. The method of claim 1 wherein step a) includes:

providing a silicon-on-insulator (SOI) substrate;
 defining the moveable element from a device layer of the SOI substrate; and
 depositing a flexible material over the device layer and the moveable element
 such that the flexible material overhangs the moveable element.

11. The method of claim 1 further comprising: minimizing an area of contact
 between the anti-stiction member and the moveable element. .

12. The method of claim 1 further comprising electrically isolating the moveable
 element from a portion of the substrate.

13. The method of claim 12 wherein the isolating step includes interposing an
 insulating material between the anti-stiction member and an electrically
 conductive portion of the moveable element.

14. The method of claim 12 wherein the isolating step includes interposing an
 insulating material between the anti-stiction member and the portion of the
 substrate.

15. An apparatus for reducing stiction in a MEMS device having a moveable element
 moveably coupled to a substrate, the apparatus comprising:
 an anti-stiction member that is interposable between the moveable element and the
 substrate.

16. The apparatus of claim 15 wherein the anti-stiction member is attached to the
 substrate.

17. The apparatus of claim 16 wherein the anti-stiction member is not attached to
 the moveable element.

18. The apparatus of claim 15 wherein the anti-stiction member is cantilevered
 such that the anti-stiction member overhangs the moveable element.

19. The apparatus of claim 15 wherein the anti-stiction member is made from a
 flexible material.

20. The apparatus of claim 15 wherein the anti-stiction member includes one or
 more flexible portions disposed between a fixed end and a free end.

- 1 21. The apparatus of claim 20 wherein the one or more flexible portions include at
2 least one serpentine portion.
- 1 22. The apparatus of claim 20 wherein the one or more flexible portions include at
2 least one double serpentine portion.
- 1 23. The apparatus of claim 15 further comprising a standoff attached to a free end
2 of the anti-stiction member.
- 1 24. The apparatus of claim 15, further comprising means for electrically isolating
2 the moveable element from a portion of the substrate.
- 1 25. The apparatus of claim 24, wherein the means for electrically isolating
2 includes an electrically insulating standoff attached to a free end of the anti-
3 stiction member.
- 1 26. The apparatus of claim 24, wherein the means for electrically isolating
2 includes an electrically insulating portion of the moveable element.
- 1 27. The apparatus of claim 15, wherein the anti-stiction member includes a
2 serpentine shaped portion that is disposed between a free end and a fixed end
3 of the anti-stiction member.
- 1 28. The apparatus of claim 15, wherein the anti-stiction member includes one or
2 more double-serpentine shaped portions that are disposed between a free end
3 and a fixed end of the anti-stiction member.
- 1 29. A MEMS device, comprising:
2 a substrate;
3 a moveable element moveably coupled to the substrate, and
4 an anti-stiction member that is interposable between the moveable element and the
5 substrate.
- 1 30. The MEMS device of claim 28 wherein the anti-stiction member is attached to
2 the substrate.

- 1 31. The MEMS device of claim 30 wherein the anti-stiction member is not
2 attached to the moveable element.
- 1 32. The MEMS device of claim 28 wherein the anti-stiction member is
2 cantilevered such that the anti-stiction member overhangs the moveable
3 element.
- 1 33. The MEMS device of claim 29 wherein the anti-stiction member is made from
2 a flexible material.
- 1 34. The MEMS device of claim 29 wherein the anti-stiction member includes one
2 or more flexible portions disposed between a fixed end and a free end of the
3 anti-stiction member.
- 1 35. The MEMS device of claim 29, wherein the one or more flexible portions
2 include a serpentine portion.
- 1 36. The MEMS device of claim 29, wherein the one or more flexible portions
2 include at least one double-serpentine portion.
- 1 37. The MEMS device of claim 29 further comprising a standoff attached to a free
2 end of the anti-stiction member.
- 1 38. The MEMS device of claim 29 further comprising means for electrically
2 isolating the moveable element from a portion of the substrate.
- 1 39. The MEMS device of claim 38, wherein the means for electrically isolating
2 includes an electrically insulating standoff attached to a free end of the anti-
3 stiction member.
- 1 40. The MEMS device of claim 39, wherein the means for electrically isolating
2 includes an electrically insulating portion of the moveable element.
- 1 41. The MEMS device of claim 29 wherein the moveable element includes a light-
2 deflecting component.
- 1 42. The MEMS device of claim 41, wherein the light-deflecting component is
2 plane reflecting (or partially reflecting) surface, curved reflecting (or partially

3 reflecting) surface, prismatic reflector, refractive element, prism, lens,
4 diffractive element, grating, fresnel lens, dichroic coated surface, waveguide or
5 some combination of these.

1 43. The MEMS device of claim 41 wherein the light-deflecting component is a
2 mirror.

1 44. The MEMS device of claim 29, wherein the moveable element is configured to
2 rotate.

1 45. The MEMS device of claim 29, wherein the moveable element is configured to
2 translate.

1 46. A method for fabricating a MEMS device, comprising:
2 providing a silicon-on-insulator (SOI) substrate;
3 defining a moveable element from a device layer of the SOI substrate; and
4 depositing a flexible material over the device layer and the moveable element such
5 that one or more portions of the flexible material overhang the moveable element,
6 wherein the flexible material is deposited such that the anti-stiction member is
7 attached to one end to a portion of the device layer,
8 wherein the flexible material is deposited such that the anti-stiction member is not
9 attached to the moveable element;
10 whereby the flexible material forms one or more anti-stiction members.

1 47. The method of claim 46 wherein an insulating material is deposited between
2 defining the moveable element and depositing the flexible material.

1 48. The method of claim 47, further comprising etching the insulating material to
2 release the moveable element.

1 49. The method of claim 48, wherein the flexible material is resistant to an etchant
2 that is used to remove the insulating material.

1 50. An optical switch, comprising:
2 a substrate;
3 one or more moveable elements moveably coupled to the substrate, and

- 4 an anti-stiction member that is interposable between at least one of the moveable
5 elements and the substrate.
- 1 51. The optical switch of claim 50 wherein at least one of the moveable elements
2 includes a light-deflecting component.
- 1 52. The optical switch of claim 51 wherein the light-deflecting component is a
2 plane reflecting (or partially reflecting) surface, curved reflecting (or partially
3 reflecting) surface, prismatic reflector, refractive element, prism, lens,
4 diffractive element, grating, fresnel lens, dichroic coated surface, waveguide
5 or some combination of these.
- 1 53. The optical switch of claim 51 wherein the light-deflecting component is a
2 mirror.
- 1 54. The optical switch of claim 50 wherein the anti-stiction member is attached to
2 the substrate.
- 1 55. The optical switch of claim 54 wherein the anti-stiction member is not
2 attached to the moveable element.
- 1 56. The optical switch of claim 50 wherein the anti-stiction member is
2 cantilevered such that the anti-stiction member overhangs the moveable
3 element.
- 1 57. The optical switch of claim 50 wherein the anti-stiction member is made from
2 a flexible material.
- 1 58. The optical switch of claim 50 wherein the anti-stiction member includes one
2 or more flexible portions disposed between a fixed end and a free end of the
3 anti-stiction member.
- 1 59. The optical switch of claim 58, wherein the flexible portion includes a
2 serpentine portion.
- 1 60. The optical switch of claim 58, wherein the flexible portion includes at least
2 one double serpentine portion.

- 1 61. The optical switch of claim 50 further comprising a standoff attached to a free
2 end of the anti-stiction member.